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COMMUNICATIONS RESEARCH CENTRE CANADA | STRATEGIC PLAN

# 2011-2014

*Strengthening Canada's Excellence in  
ICT Research and Innovation*



Aussi offert en français sous le titre

**Plan stratégique 2011-2014 du CRC : Renforcer l'excellence du Canada  
en recherche et en innovation dans le domaine des TIC**

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## 1.0 ABOUT CRC

The Communications Research Centre Canada (CRC) is the federal government's primary laboratory for research and development in advanced telecommunications, and a centre of excellence in information and communications technologies (ICT). Its capabilities cover satellite communications, terrestrial wireless, multimedia, broadcasting and broadband networks.

### 1.1 Vision

To be the federal centre of excellence for ICT research in Canada.

### 1.2 Mission

- To be the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes;
- To support government operations led by major clients in selected areas of ICT application such as defence, public safety and space-based communications;
- To stimulate the growth and evolution of Canada's communications sector by engaging in industry partnerships, performing technology transfer and working with universities and other research organizations; and
- To advance Canada's global reputation as an ICT research leader by engaging in international collaborations and partnerships.

### 1.3 Values

- Research Excellence
- Scientific Integrity
- Commitment to Clients
- Respect and Fairness
- Teamwork and Open Communication

## 2.0 EXECUTIVE SUMMARY

ICT has been identified as a major priority of the Government of Canada in the Science & Technology Strategy. Canada's digital economy strategy (DES) identifies the importance of ICT as a catalyst for driving innovation and productivity. Other government departments (OGDs) have also identified ICT as a key driver for tomorrow's way of doing business.

At the same time, in response to the recent global recession, the Canadian government has implemented directives to curtail program spending as well as increase operational efficiency for the next three years. Departments are working to identify opportunities to contain new spending by reallocating existing spending to priority areas.

CRC will respond to these opportunities and challenges by aligning research priorities and consolidating some research programs to focus on activities that respond to the goals set out in the digital economy strategy. CRC will concentrate funding in the following four priority research areas, selected based on client needs, core capabilities and emerging trends:

- Spectrum Research
- Defence, Public Safety & Security
- Emerging Network Infrastructure
- ICT Applications & Adoption

Under these four priority research areas, ten horizontal research programs have been identified: efficient use of spectrum, new spectrum bands, spectrum agile networks, and spectrum monitoring; defence communications, public safety communications, and cyber security; next-generation communications networks, and Green ICT; and advanced technology test beds. Consolidating existing research under these ten programs will involve growing some programs, while shrinking others.

Research will be focused along these ten programs to increase synergies between the various R&D groups at CRC. This will allow CRC to continue to take advantage of the skill sets across its various branches, as well as ensure efficient use of resources and coordination of activities for sustained impact.

CRC activities will range from theoretical studies to demonstrations of applications and will include computer simulations, prototyping, software implementations, laboratory and field tests, as well as end-user software and hardware solutions.

Ensuring that CRC activities respond to the needs of its major government clients will continue to be the main priority. Accomplishing this during a period of fiscal restraint will require an increased level of coordination and cooperation, both within CRC and through its partnership with Industry Canada (IC), the Department of National Defence (DND), the Canadian Space Agency (CSA), Public Safety Canada (PSC), the National Research Council (NRC), Natural Resources Canada (NRCan) and other government organizations. Programs will be defined by CRC in collaboration with its government clients, and with the strategic, targeted advice provided by CRC's Advisory Council. Teams with multi-



disciplinary expertise will be put together to best respond to clients' needs. Leveraging, which has been key to the success of CRC, will be increased, resulting in R&D programs with multiple contributing beneficiaries.

Technology transfer and contracting-in, as a natural extension of our support of government activities, will become even more strategic activities over the coming years in support of the government's larger efforts to improve Canadian productivity by accelerating the commercialization and adoption of new ICTs. CRC is already a top performer among all federal laboratories in the generation and transfer of new technologies to companies, particularly small and medium-sized enterprises (SMEs), for commercialization and sales to a worldwide market. CRC will seek commercialization opportunities by targeting technology areas close to commercialization. In addition, patents will continue to be generated. And CRC will continue to impart know-how and advice in collaborations with industry – collaborations that see companies capitalizing on CRC testing and demonstration facilities.

CRC will continue to collaborate with universities and other research organizations in Canada and around the world, to reach common goals by combining our efforts and expertise in complementary areas. This will facilitate CRC participation in early-stage research on potentially disruptive technologies. It will also allow CRC to help bridge the gap between Canadian universities and industries, once these technologies are ready for technology transfer. What's more, maintaining visibility with Canada's bright young graduate student researchers will enhance ongoing rejuvenation of CRC's talent pool.

#### Results that Matter: The CRC Commercialization Engine

Total licensing and contract R&D revenue: \$29 million (2001-2010)

Number of active IP licences worldwide: 526

Number of active IP licences in Canada: 197

Canadian sales due to technology transfer from CRC: \$408 million (2001-2010)

Canadian person-years of employment: 2040 (2001-2010)

CRC spin-off companies: 10 (2001-2010). In 2010, the total sales of these 10 companies was \$179 million and total employment was 742.

Source: Doyletech Report, 2011 and CRC Highlights 2009-2010

CRC is recognized within Canada and internationally for its scientific integrity and excellence. Looking ahead, CRC will ensure that its core technological capabilities – particularly those relevant to priority research areas – are maintained at a world-class level. In the first year of this plan, these capabilities will be peer-reviewed and refocused to better contribute to CRC's goals.

To mitigate the impact of escalating costs for campus infrastructure maintenance on research program funding, CRC will reduce its physical building footprint. CRC will also aggressively target federal programs that will help fund energy-saving measures across all its facilities.



## 3.0 INTRODUCTION

The Communications Research Centre Canada is pleased to present its 2011-2014 Strategic Plan: **Strengthening Canada's Excellence in ICT Research and Innovation.**

As Canada's federal centre of excellence for information and communications technologies (ICT), CRC provides technical advice and support to Industry Canada's Spectrum, Information Technologies and Telecommunications Sector (IC-SITT), the Department of National Defence (DND), the Canadian Space Agency (CSA), Public Safety Canada (PSC) and other government departments (OGDs) and agencies in efforts ranging from establishing policy, regulations and standards, to developing satellite communications, defence, and public safety and security applications.

As CRC government clients address key national priorities, they use CRC's independent and impartial research to inform their regulatory, policy, program and technical decisions, as well as standards development. Technology developed in support of clients is often commercialized, advancing innovation and the economic well-being of Canadians.

The next three years will see CRC increase its focus on government policies and priorities that are important to Canada's economic development and social well-being. Among the drivers over this period will be the digital economy strategy that will encourage the ICT sector to create new products and services, and the accelerated adoption of digital technologies designed to promote a stronger, more competitive and innovative economy. As OGDs work through evolutionary changes to their communications infrastructure, CRC will be available to provide needed technical expertise.

While client-driven research is the cornerstone of the R&D Program, there remains a need for CRC to explore new technologies of potential future importance to Canada. This fuels future research projects and creates new intellectual property and additional commercialization opportunities.

The 2011-2014 Strategic Plan highlights how the Communications Research Centre will align its priorities with those of its clients to ensure the effective and efficient provision of CRC's expertise.



## 4.0 A CHANGING LANDSCAPE: CHALLENGES & OPPORTUNITIES FOR CRC

The global telecommunications landscape is constantly evolving, presenting new challenges and opportunities for the Canadian government as it aims to encourage better use of emerging ICT products, applications and services, as a way of improving economic growth, security and quality of life.

ICTs represent one of the most powerful tools for enabling innovation and productivity. The production of new hardware and software technologies, and the adoption of these technologies across a range of industry sectors, contribute to cost-savings, efficiencies, improved productivity, as well as new market and ICT employment opportunities.

### Canadian ICT Sector Profile - 2009

- 31,500 companies comprise ICT sector
- 100 companies with more than 500 employees
- ICT sector generates \$154 billion in revenues (ICT sector revenues have increased by more than 19% since 2002, or about 2.5% annually)
- 544,900 employees in ICT sector (0.6% increase over 2008)
- ICT industry is the largest private sector R&D performer, generating \$6.2 billion (2.5% increase over 2008; 38.5% of total private sector R&D expenditures)

Source: [http://www.ic.gc.ca/eic/site/ict-tic.nsf/eng/h\\_it06257.html](http://www.ic.gc.ca/eic/site/ict-tic.nsf/eng/h_it06257.html)

The importance of this sector is reflected in several recent federal government policy papers, including the S&T strategy, the cyber security strategy and the defence S&T strategy, as well as the more recent digital economy strategy, which focuses on strengthening the Canadian ICT sector, expanding capacity to innovate through adoption and use of ICTs in Canada, and ensuring a world-class network infrastructure for Canada.

Building on Canada's strength in ICT requires, among other ingredients, a continued commitment to scientific innovation and excellence, informed public policy, highly qualified people, standards and regulations, as well as strong collaboration among various government, academic and industrial stakeholders.

As Canada's federal centre of excellence for ICT R&D, CRC supplies some of these ingredients: a continued commitment to scientific excellence, highly qualified people, a culture of collaboration, and a proven track record in working at all levels of the ICT innovation chain – from basic research to technology development, training, standards development, and technology transfer.



### Results that Matter:

Canada is recognized globally for its international reputation as an ICT research leader, just as CRC is recognized on the world stage for its research in communications technologies. This recognition results in opportunities for collaboration with research organizations around the world. Expertise also earns CRC a seat at international standards tables. Standards promote harmonization, economies of scale and interoperability, and reflect Canadian interests when the country is represented. Maintaining CRC's expertise is vital to government regulators, defence authorities, broadcasters, ICT sector manufacturers and others in Canada's telecommunications community.

## 5.0 STRATEGIC DIRECTIONS AND ENABLERS

The strategic directions taken by CRC at this juncture, and outlined below, will position the organization to innovate on behalf of its clients and contribute to Canada's digital economy.

### DIRECTIONS

#### 5.1 Supporting spectrum management

As the world is shifting towards broadband mobile connectivity, the demand for radio frequency (RF) spectrum is increasing drastically and, as a result, management of the radio spectrum to ensure efficient use and limited interference is becoming more and more challenging. CRC is a key contributor in providing Industry Canada's Spectrum, Information Technologies and Telecommunications (SITT) sector with a solid technical base to: develop policy and standards for effective regulation of radio spectrum; open new spectrum or reallocate existing bands for new applications; gain insight into emerging communications technologies that can optimize spectrum efficiency and introduce new wireless services; and monitor the radio spectrum, enabling government inspectors to be more proactive in spectrum-usage surveillance. By so doing, CRC is supporting SITT's mandate to accelerate Canada's economic growth and innovation through the effective use of the RF spectrum and the development and use of ICTs, as well as Industry Canada's mission to foster a growing, competitive, knowledge-based Canadian economy.

#### 5.2 Actioning the digital economy and ICT strategies

The digital economy strategy (DES) and the ICT industry strategy will become important and visible government ICT initiatives in the upcoming years. As the federal ICT research laboratory, CRC will support the implementation of the DES and ICT strategy by clearly identifying and shifting resources to areas advancing the impact and success of these

strategies. This will contribute to Canada having a dynamic and innovative ICT industry recognized as a leader in serving both Canadian and global ICT markets; Canada having a safe and reliable environment for e-commerce that ensures trust and confidence; increased ICT use by Canadian businesses so that they can be innovative and better able to participate in the global digital economy; Canada having a network infrastructure that supports growth of the economy and responds to the economic and social requirements of Canadians; and Canadians in rural and remote communities having access to the broadband services they need.

### **5.3 Partnering with the Department of National Defence and Public Safety and Security Organizations**

CRC provides strategic advice on emerging communications technologies, performs research that supports capability development for the Canadian Forces and first responders, and works with the defence industry plus the public safety community. CRC will increase its role in preparing both DND and the Canadian defence industry for future military procurements by first engaging DND more at the senior level, and developing a greater presence in each other's strategic planning forums. Providing the Canadian Forces with solid data to support planning, procurement and deployment of new military communications hardware will now be carried out with the benefit of this senior, strategic involvement. Overall, CRC's contribution will advance the communications capabilities of military and civilian forces as they respond to a range of situations both at home (e.g. search and rescue operations, flooding and other emergencies) and abroad (e.g. international conflicts, natural disaster relief mission).

### **5.4 Supporting other government departments and agencies**

As the federal centre of excellence for ICT research, CRC will continue to work with other government departments and agencies on initiatives of mutual interest, including: expanding satellite communications that benefit Canada's social, scientific, sovereignty, security, and foreign policy objectives, through work with the Canadian Space Agency; and providing a solid technical base to the Canadian Radio-television and Telecommunications Commission (CRTC) as it ensures broadcasting and telecommunications systems serve the Canadian public. These examples represent the many CRC initiatives that encourage useful technical collaborations and contributions, and advance the organization's mission.

### **5.5 Helping industry through technology transfer**

One important by-product of CRC's research program for government is the creation of intellectual property (IP) and other technical know-how. Canada's Science and Technology Strategy, announced in 2007, promotes commercialization of research by all participants including federal labs. CRC will therefore continue to support technology transfer efforts to industry by licensing its IP, partnering in joint R&D projects, providing access to its specialized test beds and sharing its technical know-how. This activity advances the mandate of Industry Canada: to help make Canadian industry more productive and competitive in the global economy, thus improving the economic and social well-being of Canadians.



## ENABLERS

### 5.6 Consolidating programs while keeping critical mass

To increase the impact of our research activities and continue to maintain world-class programs in a constrained budgetary environment, CRC will consolidate research programs and increase synergies between groups. This will provide clients with greater access to CRC's total range of technology expertise.

### 5.7 Maintaining excellence and prioritizing in pursuit of goals

To be a viable research organization, CRC must ensure its technological capabilities are maintained at a world-class level. One of the indications of excellence will be external validation of CRC research through publication in international peer-reviewed scientific journals and presentations at international scientific conferences. Research programs will be peer-reviewed with a view to making any adjustments to better contribute to priority areas.

### 5.8 Reducing CRC's footprint and securing funds for energy efficiencies

Campus operations expenses are increasing as its infrastructure ages and energy costs rise. Some buildings are reaching a critical stage beyond which they will be very difficult to repair cost-effectively. CRC will reduce the space it occupies on the overall campus and aggressively target federal programs that will help fund energy saving measures.

#### Fuelling Canada's supply of Highly Qualified People

*Research Centre Canada is a leading provider of highly qualified people (HQP) to the Canadian economy.*

CRC boasts a strong contingent of highly qualified people (HQP) who help fuel Canada's HQP supply. Every year, roughly 40 students come to CRC, where their talent is nurtured. Many of these new HQP continue to innovate well into the future, to the benefit of the Canadian economy. Experts conducting post-doctoral research, visiting fellows, CRC researchers serving as adjunct professors, and those collaborating with universities enrich the exchange between CRC and academia. As career paths evolve, some CRC engineers and scientists bring their expertise to academia or the private sector on a full-time basis.

## 6.0 PRIORITY RESEARCH AREAS

Each of the four priority research areas – Spectrum Research; Defence, Public Safety & Security; Emerging Network Infrastructure; and ICT Applications & Adoption – will contribute to one or more of the following elements of CRC's mission:

- To be the federal government's centre of excellence for communications R&D, ensuring an independent source of advice for public policy purposes;
- To support government operations led by major clients in selected areas of ICT application such as defence, public safety and space-based communications;
- To stimulate the growth and evolution of Canada's communications sector by engaging in industry partnerships, performing technology transfer and working with other research organizations; and
- To advance Canada's global reputation as an ICT research leader by engaging in international collaborations and partnerships.

### 6.1 SPECTRUM RESEARCH

Advances in wireless technology, coupled with the convergence of content and applications, have fuelled demand for spectrum. In Canada and around the world, innovators are devising new ways to add interactive broadband features to existing services, exploit increasingly higher frequencies or tap into the white space left unused in various radio frequency (RF) bands. Each new demand produces unique technical and public policy challenges that can impact existing services, require a new government policy or regulation, or even new models governing spectrum use. Industry Canada, CRC's chief client for spectrum research, requires evaluation studies, technology testing, impact assessments on electronic and electrical devices and systems, and more.

The Spectrum Research priority area is comprised of the following four research programs:

#### 6.1.1 Efficient use of spectrum

Radio spectrum is a scarce resource and demand for it is increasing at an unprecedented pace to meet the requirements of modern applications. CRC will continue to support SITT and other clients in managing this finite resource by developing techniques and technologies to increase the efficient use of currently allocated spectrum.

**Scope:** CRC R&D will focus on methods, techniques and technologies that can maximize the use of the RF spectrum to deliver various wireless services (e.g., 4G, 5G, satellites, broadcast TV and radio) as well as advanced applications that require spectrum (e.g., intelligent transportation, energy management and public safety). Multimedia compression, modulation, coding and access techniques, as well as various hardware-centric approaches (e.g., MIMO, or multiple-input, multiple-output) will be investigated and advanced. Characteristics and performance of technologies, as well as their interaction within the RF medium (e.g., interference generation/protection and coexistence), will be studied.

**Output:** Knowledge and information, including enhanced radio environment characterization, valuable in identifying the most spectrum-efficient technologies and combinations thereof. Results will be communicated through reports, presentations, demonstrations,



participation in discussions, and contributions to appropriate domestic and international technology and standardization activities.

**Outcome:** Clients will be better equipped to plan for improved communication services. Industry Canada will have the solid technical base required to regulate spectrum allocation. This will also result in a more efficient use of the spectrum footprint by enabling more users and applications to coexist in a dynamic and efficient manner.

### 6.1.2 New spectrum bands

Advances over the last 20 years have fuelled demand for spectrum in both licensed and license-exempt bands. Some of this demand has been met by increased sharing of spectrum among services, given more efficient communications techniques and technologies. But demand continues to exceed the capacity that can be gained by frequency sharing, so opening up and/or reallocating frequency bands to accommodate new applications must be explored.

**Scope:** CRC will study the propagation characteristics of radio waves and evaluate the suitability of various frequency bands to carry new wireless applications, in support of spectrum allocation.

**Output:** Propagation models, ITU-R submissions, software simulating the propagation and coverage of radio waves, reports and contributions to regulators and users on specific propagation issues. Results will be shared with other programs investigating techniques and methods of using spectrum, and with the advanced technology test beds program (6.4.1) for use in demonstrations.

**Outcome:** Industry Canada will have key technical advice needed when weighing factors prior to opening new frequency bands (e.g., 40/50 GHz for satellite communications) and/or reallocate existing ones (e.g. 700 MHz, 2.5 GHz), thereby better serving government agencies and Canadians. OGDs and commercial wireless network operators will also obtain insight to improve service. Decisions on frequency allocation taken at the ITU-R will be supported by technical data taking into account the particularities of Canadian geography.

### 6.1.3 Spectrum agile networks

The proliferation of wireless devices, coupled with broadband requirements, necessitate new approaches to sharing spectrum for efficient coexistence. Wireless networks and terminals embodied with cognitive intelligence will be able to coexist and collaborate with systems sharing the same spectrum. Such networks will have to quickly adapt to changing interference and bandwidth requirements, forcing the development of software-based approaches to radio resource planning and spectrum policy to enable spectrum use and sharing.

**Scope:** Techniques and methods to optimize the coexistence of wireless devices in a limited spectrum environment (i.e., cognitive radio technologies) will be the central elements of this program. Dynamic spectrum allocation and other network management approaches will be investigated.

**Output:** New techniques and technologies will be developed, demonstrated and evaluated within operational environments typified by new ISM band and 4G (LTE) cellular

applications. This could lead to the use of ISM band technologies to augment broadband cellular (for example smart phone operation based on a hybrid of Wi-Fi and LTE functions), or to the development of cognitive femtocell applications derived from modifications to the LTE standard.

**Outcome:** This research program will provide insight into emerging communications technologies that can optimize coexistence of wireless devices in a limited spectrum environment. This will benefit Industry Canada, enabling it to better optimize spectrum allocation, and regulate new collaborative and autonomous wireless devices. IC and other clients will be better equipped to plan for future communications systems.

#### 6.1.4 Spectrum monitoring

The demand for broadband mobile communications poses a significant challenge on the crowded frequency spectrum. Spectrum planning and authorization can no longer assure coordinated, interference-free and optimally efficient spectrum use. Spectrum monitoring is integral in the continuum of regulatory approaches. And it will continue to be an important tool in ensuring that technological advances in communications systems, based on spectrum sensing and cognitive decision-making, realize their potential to autonomously adapt frequency usage to minimize interference.

**Scope:** This program will centre on developing advanced techniques to monitor radio spectrum and adapt frequency usage to ensure its efficient exploitation. Spectrum monitoring in the lower bands (100 MHz - 6 GHz), where congestion is most often noticed, will be the focus.

**Output:** New techniques to identify and locate sources of interference in real-time will be developed. Updated spectrum surveillance and monitoring tools will be developed for Industry Canada radio inspectors and other government organizations that have a need to monitor spectrum activities (e.g., National Defence, airport and harbour authorities, Coast Guard, Canadian Space Agency). Signal processing algorithms and codes will also be made available to these groups seeking to improve their offerings.

**Outcome:** Improved capability for Industry Canada radio inspectors to quickly identify and keep radio interference to a non-harmful level will result. This will ensure that auctioned / licensed spectrum is fully available to the successful bidder. Other departments will be able to ensure independently that their operations are performed in optimal spectral conditions. Technology developed here will be a key element of future cognitive radio systems.

#### Key achievement

Industry Canada used CRC's suite of radio frequency spectrum monitoring and surveillance technologies (Spectrum Explorer®) to provide spectrum management and interference mitigation at the 2010 Olympic and Paralympic Winter Games in Vancouver.



## 6.2 DEFENCE, PUBLIC SAFETY & SECURITY

Public safety and security threats and risks have become more complex. Consider not only the diversity of natural hazards, but also transnational threats including terrorism, globalized disease outbreaks, climate change, interdependent critical infrastructure, and attacks on information systems or networks. Effective communications are critical for public safety, national security and emergency preparedness agencies to communicate in emergencies. Security of communications is also a major issue for the conduct of business transactions over networks, as well as for applications such as defence networks. This strategic priority area targets communications in capacity-limited frequency bands, search and rescue by satellite, autonomous systems and cyber security. Much of the work is carried out for, or in partnership with, other federal organizations.

The Defence, Public Safety and Security priority area is comprised of the following three research programs:

### 6.2.1 Defence communications

CRC works with DND, its research agency Defence Research and Development Canada (DRDC), as well as with allied organizations and international standards bodies to develop improved ICT capabilities for the military. CRC provides support to DND and DRDC under the terms of an MOU between DND and Industry Canada. Project plans are reviewed and negotiated with the client annually.

**Scope:** This program involves niche R&D on future military network systems and technologies, with a focus on techniques and algorithms for use in secure communications and surveillance applications. Specific project areas include research on mobile wireless communications systems and networks, network management and security, battlefield radio spectrum use and management, autonomous networked systems, broadband satellite communications, and the application of broadcasting technologies to defence. Increased emphasis will be placed on transferring technology to potential military contractors, strategically engaging DND more at the senior level, and introducing DND to a broader range of CRC capabilities.

**Output:** Reports of system studies and designs to DND, plus demonstrations and field trials of new communications systems will result. In addition, CRC will participate as technology experts in NATO, ITU, the Technical Cooperation Program (TTCP) and other technology development and standards meetings.

**Outcome:** The Canadian Forces will have solid data and access to the expertise of trusted advisors to support planning, procurement and deployment of new military systems that rely on communications. The Forces will also have improved Canadian military industrial capability through the transfer of intellectual property, while industry will have access to that IP.

### 6.2.2 Public safety communications

Saving lives depends, in part, on the ability of emergency responders to talk and transfer images or data as required. To this end, CRC will work with Public Safety Canada

through the Interoperable Development Office to develop and test improved communications capabilities for Canada's first responder community. Broadband and interoperability will be the main focus of the effort. Technical support will be defined under a series of project plans negotiated annually.

**Scope:** The program involves R&D in niche technical areas to improve public safety and security-related communication systems. Activities will focus on techniques to improve communications interoperability (e.g., software defined radio), radio coverage, and detection and alert systems, as well as on methods to enable public safety systems with multimedia capabilities. Test beds will be implemented to trial equipment, novel methods and new technologies. R&D will be conducted at multiple levels including physical link, network, security, architecture, and radio propagation.

**Output:** Advice on technology trends and capabilities delivered in reports, presentations and specifications to government stakeholders; development of innovative solutions and proofs-of-concept leading to the next generation of communications and alert systems; and demonstrations and field trials of CRC and industry-developed technologies.

**Outcome:** Industry Canada, DND, Public Safety Canada and public safety organizations will have the technical details needed for the definition and acquisition of next-generation interoperable, broadband public safety communications systems, thereby enabling faster and better operations to the benefit of Canadians.

#### Results that matter

In the 1970s, CRC research was critical to the creation of the COSPAS-SARSAT system enabling search and rescue satellite-aided tracking (SARSAT). After more than 30 years with over 25,000 people rescued by this international consortium, CRC research continues to improve the system by supporting the introduction of the service over medium-earth-orbit (MEO) satellites. CRC hosts Canada's only MEO SARSAT experimental ground station.

### 6.2.3 Cyber security

Considering the launch of a national cyber security strategy in 2010, cyber security is a major concern of industry, government and Canadian citizens alike. Cyber attacks take many forms and can have serious consequences on Canada's critical communications infrastructure impacting individuals, business and national security. As attacks become more sophisticated, it is important to have both an awareness of new and emerging threats, as well as a means to identify and mitigate attacks. CRC has substantial background and expertise in secure military communications providing the underlying capacity to contribute effectively and work with multiple partners including Public Safety Canada, Defence R&D Canada, National Defence, the Communications Security Establishment Canada and the telecommunications industry.



**Scope:** As part of a larger Canadian effort in cyber security research, CRC contributes to advances in detection, analysis and response to cyber security attacks. Research is automating the identification of malicious activities and the characterization of cyber threats and attacks, and is developing new evaluation criteria and new methods to improve the accuracy of cyber security technologies. Another line of research is examining the application of trust reasoning to ICT network security. Trust and comfort technologies will augment and strengthen existing security processes and technologies. Devices and components within the ICT infrastructure may be instrumented to actively monitor network status, detect anomalous and emergency situations, and take appropriate response actions to enhance their security posture and mitigate the negative impacts of an attack.

**Output:** New algorithms to improve the accuracy of current intrusion-detection systems in detecting and verifying attacks, the identification of trends in new malware releases, and the application of trust-management methodologies to network security will all result.

**Outcome:** Industry Canada and other clients will have a better understanding of technologies that can identify, analyze and mitigate new cyber security threats. Clients including the Canadian Forces will be ready, or better prepared, for the next generation of tactical wireless deployments.

## 6.3 EMERGING NETWORK INFRASTRUCTURE

Given its vast geography and low population density, Canada needs a communications infrastructure advantage for leadership in the digital economy. The country's communication network infrastructure has to be the best possible in terms of functionality, adaptability and sustainability. In order to provide technical advice to Industry Canada, National Defence and other government and industry stakeholders, CRC must explore next-generation networks such as 5G, which promise new functionality (e.g., communication between machines and with sensors), more efficient transmission systems, and support of improved services. CRC must also research Green ICT, which offers techniques and services for reducing ICT's carbon footprint by facilitating cloud computing, among other approaches.

The Emerging Network Infrastructure priority area is comprised of the following two research programs:

### 6.3.1 Next-generation communications networks

The evolution of wireless communications and broadcasting has followed industry standards as set out by the ITU and other international bodies. Each gradation, occurring roughly every 10 years, results in an increased capacity available to end users. As the world moves toward next-generation systems, there is also an ongoing shift from network-centric to service-centric communications in an all-IP-based environment. The program will evaluate and characterize new wired and wireless technologies, architectures and transmission systems that will make next-generation networks a reality, including the convergence of communications and broadcasting networks. Exploring new technologies of potential future importance to Canada fuels future research projects, and creates new intellectual property and additional commercialization opportunities.

**Scope:** Projects will focus on specific technologies and architectures that enable higher-capacity wireless systems as defined by 4G/5G terrestrial systems and next-generation

broadband satellite communications; audio-video compression, transmission and reception technologies to better integrate fixed and mobile broadcast services with the future Internet; integrated photonic components for optical and sensor networks; and satellite system technologies to increase coverage and capacity. The choice of areas of investigation considers a number of factors including worldwide technology trends in communications, applicability to Canadian needs including industrial receptor capacity, and the skill sets available at CRC to carry out the work.

**Output:** Reports and briefings to SITT and other clients on new communications technologies, as well as timely replies to technology-related questions, will result. CRC technical experts will participate in selected meetings of the ITU and other international standards fora. New innovations enhancing CRC's technology portfolio, with corresponding technology transfer, will also result.

**Outcome:** Industry Canada and other clients will have a better understanding of emerging, and possibly disruptive, network technologies and their implications on the delivery of communications services to Canadians.

### 6.3.2 Green ICT

As the federal government's centre of excellence for communications R&D, CRC not only conducts core research on behalf of its clients, it anticipates future direction in the sector and shares this insight with them. Increasing awareness of the ICT sector's contribution to global CO<sub>2</sub> emissions – and growing concern with the costs associated with fuelling IT equipment – prompted CRC's involvement in the CANARIE-funded Green ICT initiative. This is in keeping with government efforts to reduce power consumption of IT equipment. Working with lead partner École de technologie supérieure (ÉTS) and other collaborators, CRC is involved in the development of technologies used to reduce ICT's carbon footprint, in the application of ICT to monitor and reduce energy consumption, and in efforts to standardize a system of carbon accounting for the ICT sector. CRC is also applying ICTs to its own energy-reduction efforts on campus.

**Scope:** CRC will participate in the development of the GreenStar Network with nodes powered entirely by wind and solar energy. The two-year project, funded under CANARIE's Green IT program, will provide insight into the viability and scalability of such a concept, as well as methodologies to quantify the resulting reduction of greenhouse gases. In addition, CRC will develop and use ICTs to implement smart-building practices to reduce energy consumption in its facilities on the Shirleys Bay Campus.

**Output:** Methodologies to quantify reductions in greenhouse gasses as well as measurable data on greenhouse gasses. Outputs will be shared with ICT-driven companies in jurisdictions powered by coal or oil, enabling them to get carbon credits should they adopt this type of technology. Reduction of energy costs on the CRC campus will result from implementing smart-building practices.

**Outcome:** An increased potential for Canada to become a world leader in energy efficient ICTs. CRC and its partners will become model users of technologies to monitor and reduce the carbon footprint resulting from ICT and other energy consuming operations.



## 6.4 ICT APPLICATIONS & ADOPTION

Canadian companies, particularly SMEs, tend to be slower to adopt ICTs than their counterparts in many developed countries, despite clear evidence that ICT makes companies more productive and competitive. The testing and demonstration of new ICT applications at CRC – including wireless networks and services, broadband networks and digital media – can help accelerate their market acceptance and adoption by a growing number of diverse sectors. CRC has numerous technology-specific test beds to undertake this work, including a 7 km wireless test network developed as part of CRC's WISELAB to verify interoperability between next-generation networks and legacy networks. CRC clients can also capitalize on its connectivity to CANARIE through the CRC BADLAB and Federal GigaPOP.

The ICT Applications & Adoption priority area is comprised of the following R&D program:

### 6.4.1 Advanced technology test beds

Simulations and lab bench prototyping help de-risk technology by providing independent, scientifically based performance evaluations of proofs-of-concept. Within its core areas of expertise, CRC can play a valuable role in the innovation chain by helping companies get new ideas to the marketplace quickly, given its ability to de-risk new technologies.

**Scope:** CRC software and test beds will be used by the organization and its clients to assess the performance and quality of service of new technologies and systems. Technical advice, prototypes and software will be developed and transferred to industry to support the implementation of new systems and the adoption of new technologies.

**Output:** New ICT applications will be demonstrated, resulting in the licensing and transfer of CRC technologies to Canadian industry.

**Outcome:** Access to CRC technology test beds will enable Canadian industry and government clients (e.g., DND, Public Safety Canada, Transport Canada and Coast Guard) to evaluate new communications products and services by demonstrating them in operational environments for function, interoperability and performance.

#### Results that Matter:

CRC facilitated the transition to North America's Advanced Television Systems Committee (ATSC) HDTV standard by representing Canada at technical committees developing the new system; providing the technical parameters for digital TV channel allocation; helping several Canadian manufacturers adapt their equipment to digital TV; conducting subjective testing to ensure HDTV would offer a significant enough improvement in video quality to merit the adoption of a new standard – a contribution recognized with an Emmy award in 2009; and advising the country's broadcasting industry on the implementation of the standard. This involved building Canada's first HDTV station in 1998 with funding from Industry Canada and in-kind contributions from the industry. The resulting 6 MHz HDTV digital system can accommodate more TV signals than the conventional analog NTSC system, thus providing more efficient use of the spectrum, and liberating a portion of the broadcast band that Industry Canada plans to auction to increase wireless broadband.



## 7.0 CRC ACTION PLAN 2011-2014

### **1) CRC will support Industry Canada priorities related to the ICT sector by:**

- a) Proactively building synergies with SITT sector senior managers.
- b) Developing clear and measurable outcomes to demonstrate the value-added provided to overall SITT mission.
- c) Identifying and shifting resources to support strategic priority areas, including those identified in the digital economy strategy and spectrum management program modernization.
- d) Increasing critical mass in priority research programs by taking advantage of the skill sets across CRC branches.

### **2) CRC will support DND in providing strategic advice on emerging communications technologies by:**

- a) Ensuring DND research programs become part of the overall CRC program planning process, as opposed to being a separate stand-alone program.
- b) Providing DND with expertise in a wider range of technology areas (e.g., in helping prepare DND and the Canadian defence industry for future military procurements).
- c) Planning research activities that take advantage of common Industry Canada and DND requirements.
- d) Engaging DND more at the senior level and developing a greater presence in its strategic planning forums.

### **3) CRC will provide support to ongoing and emerging government priorities by:**

- a) Working with other government departments and agencies, including CSA and PSC, on initiatives that require CRC expertise.
- b) Continuing to provide sound technical advice to assist government in developing informed policies, regulations, standards and laws related to communications technologies.

### **4) CRC will demonstrate fiscal prudence and responsibility by:**

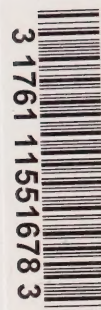
- a) Consolidating programs to ensure critical mass of funding and resources for priority areas.
- b) Developing plans and making necessary organizational changes to increase its annual revenue from contracting-in, especially from OGDs.
- c) Reducing the space it occupies on campus and hence the cost, the target being 10 percent by 2014.
- d) Targeting federal programs that help fund energy-saving initiatives.

### **5) CRC will apply the highest standards of scientific excellence by:**

- a) Maintaining its technological capabilities at a world-class level, particularly for priority research programs.
- b) Having its core technical capabilities peer-reviewed by March 2012.







[www.crc.gc.ca](http://www.crc.gc.ca)

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